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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/714,305
Filing Date: November 14, 2003
Appellant(s): CHANG ET AL.

Stephen B. Ackerman
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed April 23, 2009, appealing from the Office action mailed October 20, 2008.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

4,904,619	Yamada et al., hereinafter referred to as Yamada	02-1990

6,833,234	Bloomstein et al., hereinafter referred to as Bloomstein	12-2004
6,383,944	Furihata et al., hereinafter referred to as Furihata	05-2002
2002/0001957	Kim et al., hereinafter referred to as Kim	01-2002
5,512,334	Leuschner et al., hereinafter referred to as Leuschner	04-1996

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-2, 5-6, and 8, are rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as

Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein).

Yamada, in col 3, lines 29-64, in col 4, lines 63-68, in col 5, lines 1-13, and figure 1(a) through figure 1(d), discloses a photoresist pattern, and a liftoff method comprising forming a resist pattern (i.e., a single photoresist layer is formed on the substrate or electrode layer, exposed, and then developed the single photoresist layer to form a resist pattern) having sidewalls and an upper surface (see reference 15), performing an ion beam irradiation so as to cause hardening of the resist surface on the top portion (upper surface hardened) of the resist pattern that is resistant to chemical attack (i.e., the ion beam irradiation or sputter cleaning is too weak to etch the resist pattern surface), such that the bottom portion (shadowed region) of the resist pattern remains unhardened, exposing the resist pattern to oxidation using plasma ashing (for 5 minutes) resulting in the under cut of the photoresist pattern (unhardened bottom portion of the resist pattern eroded), wherein the top portion of the resist pattern (upper portion) overhangs the bottom shrunk portion (i.e., the bottom part of the resist pattern is thinned), forming a layer (depositing) of thin film over the resist pattern (and all exposed surfaces, i.e., all horizontal surfaces) at a thickness less than that of the bottom under cut portion (unhardened photoresist layer), removing the shrunk bottom portion of the photoresist resulting in a lift-off of the material that is deposited on the resist pattern (claim 1). Yamada, in col 4, lines 36-37, discloses that the resist is a positive resist (claim 2). Yamada, in col 5, lines 1-16, discloses that the ion beam is impinged on the resist pattern for about 3 minutes, and the top hardened layer of the

resist pattern extends to about 50nm (claims 5-6). Yamada, in col 5, lines 10-12, discloses that the hardened layer (unetched overhang) overhangs the shrunk bottom resist by about 0.1μ (bottom 200nm shorter than the top width) on each side (claim 8). Yamada, in col 5, lines 60-63, discloses that the unhardened photoresist layer (resist pattern with the undercut portion) is removed by treating the resist with the developer.

The difference between the claims and Yamada is that Yamada does not disclose exposing the resist pattern to ozone.

Bloomstein, in col 11, lines 60-67, in col 12, lines 1-7, discloses performing an ozone exposure process after exposing the resist.

Therefore it would be obvious to a skilled artisan to modify Yamada by replacing the oxygen plasma ashing with an ozone oxidation step as suggested by Bloomstein because Bloomstein, in col 14, lines 1-7, discloses that the resist surface treatment can be performed by either ozone treatment or oxygen plasma treatment, and Bloomstein, in col 19, lines 30-40, discloses that treatment with ozone as claimed increases the hydrophilicity of the surface of the resist, and increases the surface energy of the polymers in order to promote adhesion.

3. Claim 3, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein) as applied to claims 1-2, 5-6, 8, above, and further in view of U. S. Patent no. 6,383,944 (Furihata et al., hereinafter referred to as Furihata).

Yamada in view of Bloomstein is discussed in paragraph no. 6.

The difference between the claims and Yamada in view of Bloomstein is that Yamada in view of Bloomstein does not disclose that the photoresist layer thickness is between about 0.1 and 0.4 microns (claim 3).

Furihata, in col 2, lines 28-36, discloses that the resist layer thickness in the lift-off resist pattern is about 0.5μ.

Therefore it would be obvious to a skilled artisan to modify Yamada in view of Bloomstein by employing the resist thickness suggested by Furihata because Furihata, in col 2, lines 40-49, discloses that if the thickness range is beyond the range suggested the lift-off resist pattern would be less smooth to lift off.

4. Claim 7, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein) as applied to claims 1-2, 5-6, 8, above, and further in view of U. S. Patent Application Publication No. 2002/0001957 (Kim et al., hereinafter referred to as Kim).

Yamada in view of Bloomstein is discussed in paragraph no. 6.

Bloomstein, in col 12, lines 1-7, in col 15, lines 40-45, in col 24, lines 25-52, and in figure 6B, discloses using the ozone concentration of about 1-2 volume percent (i.e., 10 to 20 gm/m^3), and correspondingly the claimed flow rate as recited for performing the ozone exposure for at least a minute.

The difference between the claims and Yamada in view of Bloomstein is that Yamada in view of Bloomstein does not disclose that the photoresist pattern is exposed

to the ozone atmosphere in an ozone chamber while being heated at a temperature of about 70-150ºC.

Kim, in paragraph no. [0022], discloses that the temperature in the ozone asher (ozone chamber) is maintained at a low temperature of at least 130ºC during the ozone ashing treatment of the photoresist pattern.

Therefore it would be obvious to a skilled artisan to modify Yamada in view of Bloomstein by employing the method of using the claimed temperature range during the ozone treatment of the photoresist pattern as suggested by Kim because Kim, in [0022], discloses that maintaining the ozone asher at the claimed low temperature range enables the ashing of the photoresist pattern at a low etch rate such that the width of the photoresist pattern can be made fine without causing the pattern to fall down.

5. Claim 9, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein) as applied to claims 1-2, 5-6, 8, above, and further in view of U. S. Patent No. 5,512,334 (Leuschner et al., hereinafter referred to as Leuschner).

Yamada in view of Bloomstein is discussed in paragraph no. 6.

Bloomstein, in col 23, lines 38-65, in col 24, lines 25-45, discloses that the resist is developed at the claimed temperature range the PAB temperature is maintained, and developing time (see figure 10).

The difference between the claims and Yamada in view of Bloomstein is that Yamada in view of Bloomstein does not disclose using an NMP as the developer.

Leuschner, in col 2, lines 31-34, and in col 3, lines 20-25, discloses that the lift-off resist is heated and developed by means of N-methyl pyrrolidone (NMP).

Therefore, it would be obvious to a skilled artisan to modify Yamada in view of Bloomstein by employing the developer and developing process suggested by Leuschner because Leuschner, in col 2, lines 30-31, discloses that heating the resist enables the removal of the resist with the claimed developer, and Leuschner in col 3, lines 20-24, discloses the bottom portion of the resist together with the top hardened portion of the resist can be dissolved with a non-toxic organic solvent such as NMP.

(10) Response to Argument

I. Appellant requests the Reversal of Examiner's rejection of claims 1-3, 5-9 under 35 U. S. C. 103 (a) as being unpatentable over US 4,904,619 Yamada et al. in view of US 6,833,234 (Bloomstein et al) and further in view of US 5,512,334 (Leuschner et al.) .

(A) Appellant's <u>Overview of Yamada</u>.

(i) Appellant interprets that the photoresist pattern 15, of Yamada, in col 3, beginning from line 22, is used as a mask to shape electrode 14.

Claim 1 recites a liftoff method for photolithography by forming a resist pattern and using the resist pattern mask in the liftoff method. Yamada, in col 3, lines 29-30, and in col 5, lines 16-18, discloses that the resist pattern formed on the counterelectrode layer is used as a mask for a lift-off process i.e., the resist pattern mask is a liftoff mask. See citations below,

(14). In FIG. 1(*c*), the abovementioned resist pattern (15) is used as a mask pattern for lift-off process, and an

base electrode layer (55). Namely, the resist pattern on the counterelectrode layer (57) after reactive ion etching is used as a lift-off mask, and the insulating thin film

Therefore, Yamada teaches a resist pattern mask that is used in a liftoff process.

(ii) Appellant interprets that resist 15, is shrunk by oxygen gas plasma etching so that a small amount of electrode 15 (referred to as a terrace) now extends beyond the resist's sidewalls at its base.

Applicant is misinterpreting the terraced portion formed on the counterelectrode layer (14) at the base of the resist's sidewall of Yamada's with the claimed resist pattern overhang. Yamada, in col 3, lines 24-27, discloses that the sidewalls of the resist pattern is subjected to an oxygen plasma etching and ashing process in order to reform and shrink resist pattern sidewalls resulting in a resist pattern that has terraced-shape portions in the base area of the sidewall adjacent to the counterelectrode layer, wherein part of the sidewalls (both sides) of the resist pattern has been removed. Later on, in the same column i.e., column 3, lines 43-48, discusses the reforming and shrinking process, that the resist pattern (15) is subjected to, in detail, so that the reformed and shrunk resist pattern can be used as a liftoff mask, effectively. The reforming and shrinking process of the resist pattern not only requires a terraced portion but also an overhang, and to form a resist pattern terrace with a overhang, the resist pattern surface is hardened by sputter cleaning with high energy particles in advance i.e., prior to the plasma etching and ashing process. Also, Yamada, in col 4, lines 63-68, and in col 5, lines 1-20, discloses that a resist pattern is formed on the substrate with the

counterelectrode layer, and then the resist pattern surface is hardened (i.e., the top surface) in a sputter etching environment using oxygen gas, followed by a plasma etching and ashing process that results in a resist pattern sidewall (areas below the hardened top portion) that is shrunk considerably such that the resist pattern bottom width is smaller than the top width of the resist pattern forming an inverted trapezoidal shape i.e., a resist pattern with an overhang. This resist pattern with an overhang is used as the lift off mask. Also, the electrode 15 referred to by the Appellant is not taught by Yamada. The electrode layer of Yamada is reference 14.

(iii) Appellant interprets that insulating film 16 is deposited; and it coats the top surface of pattern 15, the exposed parts of layer 12, and the top and sides of the afore-mentioned terrace, forming what Yamada then refers to as an overhang.

Yamada teaches the formation of a liftoff mask prior to the deposition of the insulating layer 16. As discussed in paragraph (ii) above, Yamada, in col 3, lines 25-32, and lines 43-50, discloses subjecting a resist pattern formed on the counterelectrode layer to a sputter cleaning process in order to harden the resist pattern surface i.e., the top surface of the resist pattern is hardened and not the sidewalls, and performing a plasma etching and ashing process in an oxygen ambient so as to shrink the sidewalls of the resist pattern (the top surface of the resist pattern will not shrink i.e., will not etch because its surface is hardened by the exposure of the resist surface to sputter ions) resulting in a resist pattern that has a terrace and a slight overhang. Yamada, in col 5, lines 2-13, discloses that the resist pattern is exposed to a sputter etching process in an oxygen ambient such that the resist pattern surface is hardened, not etched, and that a

subsequent plasma etching and ashing in an oxygen ambient causes the sidewalls to be etched forming a shrunk resist sidewall resulting in a resist pattern taking an inverted trapezoidal shape i.e., a resist pattern with an overhang. Yamada, in col 5, lines 14-18, discloses that resist pattern, after the preceding ion etch processes (plasma etching and ashing), is used as a lift off mask, wherein an insulating film is coated onto all the exposed surfaces i.e., top surface of the resist pattern, and on the exposed surfaces of the base electrode layer. Therefore, it is not the insulating layer that forms the overhang. The resist pattern itself is subjected to processes so as to form a resist pattern that has a slight overhang. See citations below, column 3, lines 25-32,

except at the junction. Then, in FIG. 1(*b*), the sidewall of the resist pattern (**15**) on the counterelectrode layer (**14**) is reformed and shrunk by oxygen gas plasma etching and ashing to form a terrace-shaped portions (indicated by dotted circles) on the counterelectrode layer (**14**). In FIG. 1(*c*), the abovementioned resist pattern (**15**) is used as a mask pattern for lift-off process, and an insulating thin film (**16**) is deposited over the entire surface a little thicker than the counterelectrode layer

column 3, lines 43-50,

ashing. When reforming and shrinking the sidewall of the resist pattern (**15**), the cross section of the resist pattern (**15**) should preferably be terraced to have a slight overhang. To form a terrace having an overhang, it is required to harden the resist film surface by sputter cleaning with high energy particles in advance. Without this process, it is difficult to form a lift-off mask of a desired shape. Namely, the conditions of oxygen sputter

and column 5, lines 2-13, and 14-18,

the vacuum chamber, and its resist surface is hardened by sputter etching using oxygen gas under the conditions of oxygen gas pressure of 0.8 Pa, radio frequency power of 20 W and treatment time of 3 minutes. In succession, plasma ashing is conducted for 5 minutes at oxygen gas pressure of 65 Pa and radio frequency power of 300 W. As a result, the shrunk width of the resist film is about 150 nm from the end of the junction pattern, leaving a terrace on the resist film as reduced by some 100 nm. After treatment, the resist pattern is given an inverted trapezoidal shape with the bottom width about 200 nm shorter than the top width.

Then, a silicon insulating thin film for covering etched layers is formed just the same way as with the base electrode layer (55). Namely, the resist pattern on the counterelectrode layer (57) after reactive ion etching is used as a lift-off mask, and the insulating thin film (58) is deposited to a thickness of 220 nm. Then, the

(iv) Appellant interprets that pattern 15 is removed, thereby causing that portions of layer 16 that lies on the pattern's surface to be lifted off. The remainder of layer 16 is left in place including the overhang. The latter have been cited by broken lines in Yamada's figure 2.

Appellant's claim 1, recites the liftoff process in the last four lines of claim 1, see below,

depositing a layer of a material onto all horizontal surfaces to a thickness that is less than that of said unhardened photoresist layer; and

selectively removing said unhardened photoresist layer whereby all of said material that is deposited onto said hardened photoresist layer is lifted off.

Yamada, in col 3, lines 29-39, and lines 42-48, in col 5, lines 10-21, and in figure 1(d), discloses that the reformed and shrunk resist pattern with an overhang (inverted

trapezoidal shape) is used as a liftoff mask, wherein the insulating layer is deposited on the top surface of the resist pattern, and all the exposed surfaces (all horizontal surfaces) of the counter electrode (exposed terraced portion of the counterelectrode positioned adjacent the bottom of the resist sidewall), and base electrode layer, followed by a lift-off operation that removes the unhardened (bottom portion of the resist pattern is unhardened, and thus removable by the liftoff solvent) resist layer pattern along with the insulating layer that was coated on top of the resist pattern surface (top surface of the resist pattern is hardened) as illustrated in figure 1(d). Appellant's claim does not recite that the deposited layer of material formed on all the horizontal surfaces are removed. Appellant's claim recites that the portions removed due to the liftoff process is the resist pattern and the material that was deposited on the hardened photoresist layer. Material deposited on the hardened photoresist layer is not the same as the material deposited on the horizontal surfaces. Yamada removes, during the liftoff, the resist pattern and the material (insulating layer) coated on to the hardened top surface of the resist pattern, all other surfaces (horizontal surfaces) coated with insulating material is left behind. Appellant's claim does not recite a stripping process or etching process that is either simultaneously occurring during the lift off process or subsequent to the liftoff process to remove the material deposited on all horizontal surfaces. Therefore, Yamada teaches the claimed liftoff process.

(v) Appellant argues that layer 16 on the top surface of the photoresist 15 is overhanging 15, and that the overhang is the layer 16 i.e., the deposited insulation, and not a modified photoresist.

If a material is deposited on a resist pattern with an overhang, the material deposited on the overhang portion of the resist pattern will also be overhanging. As discussed in the preceding arguments viz., (ii), and (iii), it is not the insulating layer that is considered as the overhang, it is the resist pattern that has a slight overhang. Yamada, in col 5, lines 1-13, discloses the process of treating a resist pattern to form a resist pattern with an inverted trapezoidal shape i.e., the bottom of the sidewall portions of the resist pattern has a width less than that of the resist pattern top width, i.e., the resist pattern has a overhang, and is a result of a sputter ion beam etching process that only hardens the surface of the resist pattern (not the bottom of the resist pattern), followed by a plasma etching and ashing in an oxygen ambient so as to reduce the width of the resist pattern sidewalls i.e., the claimed eroding of the sidewalls. Yamada is not relied upon to disclose the exposure of the hardened photoresist layer pattern to ozone. Bloomstein is relied upon disclose the exposure of the resist layer to an ozone atmosphere. See paragraph no. 2, above. Therefore, Yamada teaches a modified photoresist pattern that has a slight overhang.

(vi) Appellant argues that the sputter etching as described by Yamada is not the same as the ion beam irradiation claimed in claim 1.

Appellant's claim 1, at lines 5-10, recites the following,

irradiating said upper surface with an ion beam having a direction parallel to said sidewalls, said ion beam comprising ions whose energy is too low to sputter said layer of photoresist;

maintaining said ion beam irradiation for a time period whereby a hardened layer is formed that extends a distance downwards from said upper surface, all remaining photoresist being unhardened;

Yamada, in col 3, lines 46-48, and in col 5, lines 2-5, discloses that the resist pattern surface (top surface) is hardened by subjecting the resist pattern to a sputter etching in an oxygen gas ambient (high energy particles) i.e., ion beam sputtering exposure. Yamada names the process a sputter etching process because the resist pattern is exposed to sputter ions of oxygen, but describes that the sputtering process only hardens the surface of the resist pattern, not etches the resist pattern surface. Appellant is also subjecting the resist pattern to an ion beam, and claims that the resist surface is only hardened. Yamada exposes the resist to an ion beam generated at a very low wattage of about 20 Watts, for a few minutes (3 minutes), and describes that the sputter etching environment only hardens the photoresist pattern surface, and does not describe the process to etch the surface. In fact, after hardening, Yamada has to subject the top-surface-hardened resist pattern to a much powerful etching environment (about 300 watts RF power) in an oxygen ambient to cause an etch on the unhardened sidewalls (bottom portions) of the resist pattern (see col 5, lines 5-11). See below,

the vacuum chamber, and its resist surface is hardened by sputter etching using oxygen gas under the conditions of oxygen gas pressure of 0.8 Pa, radio frequency power of 20 W and treatment time of 3 minutes. In succession, plasma ashing is conducted for 5 minutes at oxygen gas pressure of 65 Pa and radio frequency power of 300 W. As a result, the shrunk width of the resist film is about 150 nm from the end of the junction pattern, leaving a terrace on the resist film as reduced by some 100 nm. After treatment, the resist pattern is given an inverted trapezoidal shape with the bottom width about 200 nm shorter than the top width.

Therefore, Yamada's sputtering process is too low to sputter etch the photoresist layer, it only hardens the resist surface.

(vii) Appellant argues that Yamada teaches that all exposed surfaces are subjected to ion bombardment whereas the ion beam of the present invention impinges only on the top surface of the resist since it is directed to be parallel to the resist's sidewalls, as stated in claim 1.

Appellant's claim 1, lines 5-10, recites the following,

irradiating said upper surface with an ion beam having a direction parallel to said sidewalls, said ion beam comprising ions whose energy is too low to sputter said layer of photoresist;

maintaining said ion beam irradiation for a time period whereby a hardened layer is formed that extends a distance downwards from said upper surface, all remaining photoresist being unhardened;

Appellant, as disclosed above, does not recite that the ion beam irradiation is a selective irradiation, or that the ion beam irradiation is through a shutter, or that the

surface with the resist pattern is masked surface, except for the resist pattern portion, or that the ion beam is collimated to only impinge the resist pattern surface. The resist pattern is subjected to an ion beam irradiation, and Yamada teaches that the resist pattern surface is subjected to a sputter ion beam etching (high energy particles, ion beam particles). Yamada does not teach that all other portions are subjected to the sputter ion beam, and Yamada does not teach bombarding the sidewalls of the resist pattern with the ion beam. Yamada teaches a conventionally practiced ion beam bombardment, at a very low wattage, that hardens only the surface of the resist pattern, and does not harden the sidewalls or the bottom portions of the resist pattern. Appellant claims an ion beam irradiation that is parallel to the sidewalls. Yamada's resist pattern sidewalls are not subjected to the ion beam bombardment (because the sidewalls are not hardened), and it is therefore concluded that Yamada's ion beam exposure is also parallel to the surface of the sidewalls, resulting in only the top surface of the resist pattern being subject to the ion beam, and not the side walls.

(a) Appellant argues that the overhanging top layer seen in Yamada's drawings is not photoresist but insulation.

This has been addressed in arguments (ii), (iii), and (v) above.

(b) Appellant argues that Yamada explicitly states that high energy ion beam irradiation is to be used, and Appellant argues that, by definition, sputter cleaning works by removing some of the surface material i.e., if no material is removed, sputtering has not occurred.

As discussed in paragraph (vi) above, Yamada describes in col 3, lines 46-48, and in col 5, lines 2-5, discloses sputter cleaning with high energy particles (i.e., ion beam) to harden the photoresist pattern surface, and not to etch the resist pattern surface. Yamada does not disclose that the ion beam etched the resist surface. Yamada only desires a hardened resist pattern surface, and requires a very low wattage for the ion beam (20 watt RF power) and a very short period of ion beam exposure (3 minutes). See citations below,

slight overhang. To form a terrace having an overhang, it is required to harden the resist film surface by sputter cleaning with high energy particles in advance. Without

the vacuum chamber, and its resist surface is hardened by sputter etching using oxygen gas under the conditions of oxygen gas pressure of 0.8 Pa, radio frequency power of 20 W and treatment time of 3 minutes. In

Therefore, Yamada's low wattage sputter cleaning only hardens the surface of the resist pattern.

(c) Appellant argues that Yamada's reference to an overhang is to the small amount of deposited insulation that overhangs his terrace.

Please see arguments addressed in paragraphs (ii), (iii), and (v) above.

(B) Appellant argues that Examiner relied on Bloomstein to disclose the shrinking of photoresist through exposure to ozone, and that Yamada teaches neither an overhanging top layer of photoresist nor bombardment of ions of energy too low to cause sputtering, nor use of an ion beam whereby ion bombardment is limited to the top surface of the resist, and therefore, Bloomstein is no longer relevant.

Bloomstein is relied upon to disclose performing an ozone treatment on the resist pattern. Bloomstein is relevant because Bloomstein teaches that the exposure of the resist surface to an ozone ambient is equivalent to the resist layer exposure to an oxygen plasma. Also, as explained in paragraphs (ii), (iii), and (v) above, Yamada teaches the formation of a resist pattern with a slight overhang wherein the resist pattern, after the hardening, and shrinking process, is shaped in the form of an inverted trapezoid i.e., the resist pattern has an overhang. Yamada teaches that the ion beam bombardment that the resist pattern is subjected to, only hardens its surface, it does not etch the resist pattern surface. Also, Appellant's claim does not recite a selective ion bombardment process, or an ion beam irradiation that is masked from all other areas except the top surface of the resist pattern. This argument has been addressed in paragraph (vii) above.

(C) Appellant conclude that the examiner has mistakenly equated Yamada's insulating layer with the hardened photoresist layer of the present invention, and that the examiner has not cited prior art that teaches forming overhanging top portions by first bombarding said top layer by means of an ion beam whose ions have energies that are too low to cause sputtering.

Yamada teaches forming an overhang, by first hardening the resist pattern top-surface by a sputter ion beam process, followed by a plasma etching and ashing in an oxygen ambient to shrink the sidewalls (erode the sidewalls) so as to form a resist pattern with an overhang (inverted trapezoidal shaped resist pattern mask). The argument that Yamada does not teach a resist pattern that has an overhang is

addressed in paragraphs (ii), (iii), (v), and **(B)**, above. Also, using an ion beam whose ions have energies that are too low to cause sputtering, is addressed in paragraph (vi), and **(b)** above.

II. Appellant argues that claim 7 is patentable since it depends on claim 1, which is believed to be patentable for the reasons recorded above in section I.

Claim 1 is rejected under 35 USC 103(a) as being unpatentable over Yamada in view of Bloomstein, and for the reasons described in paragraphs (i) to (vii) and **(B)** above, and Claim 7 is rejected under 35 USC 103(a) as being unpatentable over Yamada in view of Bloomstein further in view of Kim. Yamada in view of Bloomstein teaches the claimed liftoff process of forming a resist pattern, performing a ion beam treatment on the resist pattern surface to harden its surface, and exposing the hardened (top-surface) resist pattern to an ozone exposure (or an equivalent oxygen plasma, Bloomstein) that shrinks the sidewalls of the resist pattern (Yamada), coating a material on the resist pattern surface and all horizontal surfaces (exposed surfaces of the electrode layer), and removing the unhardened resist material along with the material coated atop the hardened resist surface during the liftoff.

III. Appellant argues that claim 9 is patentable since it depends on claim 1,which is believed to be patentable for the reasons recorded above in section I.

Claim 1 is rejected under 35 USC 103(a) as being unpatentable over Yamada in view of Bloomstein, and for the reasons described in paragraphs (i) to (vii) and **(B)** above, and Claim 9 is rejected under 35 USC 103(a) as being unpatentable over Yamada in view of Bloomstein further in view of Leuschner. Yamada in view of

Bloomstein teaches the claimed liftoff process of forming a resist pattern, performing a ion beam treatment on the resist pattern surface to harden its surface, and exposing the hardened (top-surface) resist pattern to an ozone exposure (or an equivalent oxygen plasma, Bloomstein) that shrinks the sidewalls of the resist pattern (Yamada), depositing a material (insulating material) on the resist pattern surface and all horizontal surfaces (exposed surfaces of the base electrode layer), and removing the unhardened resist pattern material (bottom resist sidewall portion is unhardened) along with the material coated atop the hardened resist pattern top surface during the liftoff.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/Daborah Chacko-Davis/

Daborah Chacko-Davis
Examiner, Art Unit 1795

Conferees:

/Mark F. Huff/

Supervisory Patent Examiner, Art Unit 1795

/Anthony McFarlane/